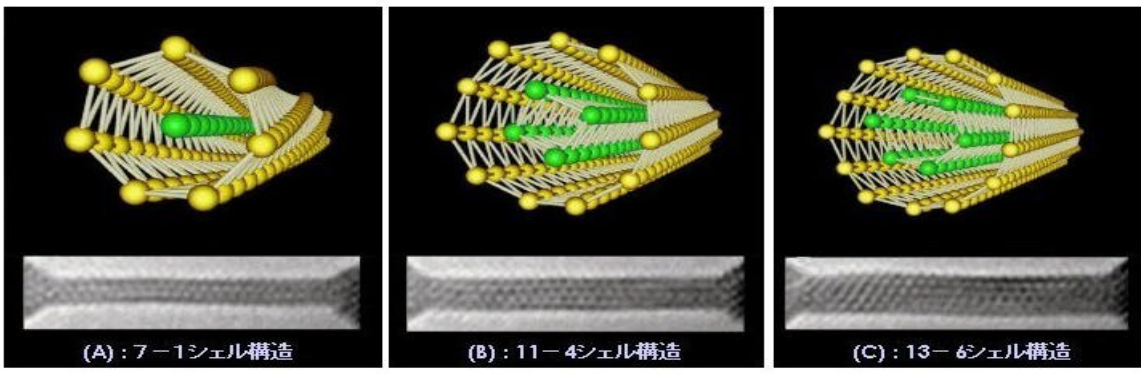
NEWS from ARO-FE (December 15, 2000): Gold nanowire with 0.6 nm in diameter and 6 nm in length. From the Takayanagi Particle Surface Project supported by the Exploratory Research for Advanced Technology (ERATO)

Nanotechnology in Japan is frequently used to describe the construction of nanostructures on semiconductors/inorganic substrates for future electronic and computer technologies also it is used to describe the development of equipment for measurement at nanometer level.

These gold nano-wires, when suspended between two electrodes, provide the important quantum properties of the electron transport. This could result in new substrate materials for nanodevices and new advances in the nanoscale electromechanical systems (NEMS).

Suspended gold nanowires were made in an ultra-high vacuum. The finest of them was 0.6 nm in diameter and 6 nm in length. By high-resolution electron microscopy, they were shown to have a multi-shell structure composed of coaxial tubes. Each tube consists of helical atom rows coiled round the wire axis. The difference between the numbers of atom rows in outer and inner shells is seven, resulting in magic shell-closing numbers.

Takayanagi Paricle Surface Project reports experimental evidence for multi-shell helical gold nanowires, as shown in the figure. High-resolution electron microscope images show



Gold nanowires with a multi-shell structure and TEM images

that gold nanowires (<1.5 nm in diameter) consist of coaxial tubes. Gold nanowires were formed in an UHV (ultra-high vacuum)-TEM with the electron beam thinning technique. A gold (001) film 3 to 5 nm in thickness

was cleaned by electron beam irradiation for 3 to 5 hours until the film showed the 5 x 20 reconstructed surface at the specimen stage of the TEM, whose vacuum was 3 $x10^{-8}$ Pa. The film was subsequently irradiated with a very intense electron beam (200 kV, 500 A/cm^2) until some holes were formed. When the bridge between two neighboring holes was narrowed, it became a long nanowire (5 to 15 nm) along the [110] direction. These nanowires (>1.5 nm in diameter) had a face-centered-cubic (fcc) structure in the core, and the lateral surfaces were reconstructed, forming a {111}-like close-packed structure. Thinned further by a weaker electron beam (100 to 50 A/cm^2), they exhibited new structures with widths (diameters) of 0.6 to 1.5 nm and lengths of 3 to 15 nm. The above procedure was successful only under UHV and with well cleaned samples. They analyzed videotapes recording the thinning process of over 30 wires (a total of 10 hours of recording).

NOTE: The USA is greatly increasing its efforts in Nano-Technology.

See Report on "Nano-Technology Research Direction" by the Interagency Working Group on Nano Science, Engineering and Technology of the National Science and Technology Council.

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